

Proposed Well Construction Regulation for the Pennsylvania Natural Gas Industry

For Pennsylvania lawmakers in consideration of amending current
gas and oil well cementing policy and practices.

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Executive Summary

This proposal calls for further exploration by lawmakers of cementing practices and standards used in Marcellus Shale natural gas well construction. Improving current legislation will help ensure minimal risk of groundwater contamination by the upward migration of down-hole fluids, an ongoing problem in Pennsylvania... Included herein are solutions addressing current state policies regarding well cementing requirements and practices. These methods are possible legislative amendments to improve best practices and ensure strict compliance with the proven standards as set forth by the American Petroleum Institute.

Problem and Background

As the new Marcellus Shale natural gas boom sweeps across Pennsylvania, there have been many concerns regarding the contamination of fresh ground water sources. Pennsylvania's Department of Environmental Protection (DEP) has documented over 50 cases of methane migration directly resulting from drilling operations (Wilber). The most common damage as a direct result of migration incidents are contamination of ground water aquifers or better known of as fresh drinking water aquifers. The current problem facing Pennsylvania, its residents and legislators are what regulations to implement to ensure the safety and protection of drinking water supplies from the gas drilling industry.

Most recently in Susquehanna County Pennsylvania, a small town has experienced the devastation of this growing problem. Thirteen residences in the town of Dimock have had their drinking water wells contaminated by migrating methane gas, along with the explosion of one of these wells (Wilber). Pennsylvania's Department of Environmental Protection found the cause of the methane migration to be a result of poor cementing of the well casing¹. The failed cementing of the well allowed methane gas to migrate upward through the annular space² of the well from the production zone to the ground water aquifer.

A natural gas well drilled to the guidelines as set forth by the American Petroleum Institute³ encompasses various methods and techniques designed to protect fresh ground water aquifers from various methods of contamination.

After the casing has been run into the drilled hole, it must be cemented in place. This is a critical part of well construction and is a fully designed and engineered process.

The purpose of cementing the casing is to provide zonal isolation between different

¹ Well Casings – metal pipes inserted into a well bore and cemented in place to protect both subsurface formations (such as ground water) and the wellbore.

² Annular Space – the space between two concentric lengths of pipe or between pipe and the hole in which it is located.

³ American Petroleum Institute – National trade association encompassing oil and natural gas industries. <http://www.api.com>

formations, including full isolation of the groundwater and to provide structural support of the well. Cement is fundamental in maintaining integrity throughout the life of the well and part of corrosion protection for casing (Hydraulic 5).

Well cementing is the key step to preventing methane and drilling fluid migration into groundwater aquifers. Failure of drilling companies to follow proper well cementing procedures and adequate protocols will lead to continued public health and safety problems throughout the state.

Current Pennsylvania legislation is abstract and arbitrary regarding cementing standards and procedural requirements of gas and oil well construction. Title 25, Section 78.81 of the Pennsylvania Code is the policy that dictates the standards and expectations for gas and oil companies to follow during well construction:

General provisions....The operator shall case and cement a well to accomplish the following:

- (1) Allow effective control of the well at all times.
- (2) Prevent the migration of gas or other fluids into sources of fresh groundwater.
- (3) Prevent pollution or diminution of fresh groundwater.
- (4) Prevent the migration of gas or other fluids into coal seams.
- (b) The operator shall drill through fresh groundwater zones with diligence and as efficiently as practical to minimize drilling disturbance and commingling of ground waters.

In addition to the general provisions, section 78.85 outlines the standards and expectations for gas and oil well cementing:

Cement standards.

- (a) The operator shall use cement that will resist degradation by chemical and physical conditions in the well.
- (b) The operator shall permit the cement to set to a minimum compressive strength of 350 pounds per square inch (psi) in accordance with the American Petroleum

Institute's API Specification 10. The operator shall permit the cement to set for a minimum period of 8 hours prior to the resumption of actual drilling....

There is only one reference to specific published API guidelines, otherwise leaving the safety and protection of the public and environment to the discretion of the drilling company. Well cementing creates hydraulic barriers⁴ between different sub-surface zones or geological formations like ground water aquifers and natural gas bearing shale. The cementing process is complicated and involved; encompassing over 50 key parameters that can potentially cause the failure of a cement job (Isolate 90-93).

Considering the above legislation and the complexity of the cementing process, Pennsylvania is naïve to expect that drilling companies are consistently exercising quality-cementing practices with utmost precision. The growing number of methane migration cases demonstrates the palpable lack of implementation of industry standards and protocols exercised by drilling companies. Their inability to put safety first warrants quick and decisive action by state lawmakers to compensate for the shortcomings.

Proposed Solution

The American Petroleum Institute provides various documents outlining cementing standards for gas and oil wells demonstrated to provide the most effective protection against sub-surface zone flows and upward gas migration. Due to the complex dynamics of and need to address each well cementing job on an individual basis, mapping out all scenarios and standards within Pennsylvania legislation to parallel API standards is simply ineffective. This proposal gives two possible legislative amendments designed to ensure high cementing standards and practices are exercised during the construction of each new Pennsylvania Marcellus Shale well drilled.

The first proposed amendment requires a state representative, employed or contracted, with sufficient industry background, to be on-site and oversee the cementing of each well. They would review

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Hydraulic barrier – an impermeable barrier created between sub-surface zones in the well bore to prevent the flow of fluid between zones.

the design and execution of the initial cementing of the well, ensuring all parameters meet API standards relative to the subsurface conditions found within that particular well.

The second proposed amendment requires drilling companies to submit various information prior to and immediately after each cementing job. Various well logging techniques provide comprehensive well data and analysis information⁵:

- Cement Bond Logs
- Variable Density Logs
- Pre/Post Drilling Logs
- Placement Simulations
- Mechanical Integrity Test Results
- Hydraulic Pressure Test Results
- Open-Hole Logs

Combination of pre and post reports will be reviewed by state personnel to ensure successful cementing and compliance with appropriate API guidelines. Building from the current permitting processes, DEP will restrict further drilling operations to prevent potential risks and hazards until a review of the various reports have verified a successful cement job.

Various forms of the proposed procedures and policies above are used in other states with great success. Currently Alaska, Michigan and Ohio require such data to be submitted, specifically Cement Bond Logs⁶ and Variable Density Logs⁷ immediately after the completion of a cement job (United States 21).

⁵ Well logging – general term that encompasses all forms of surveying and data collection conducted inside a borehole to gather information about the subsurface formations.

⁶ Cement Bond Log (CBL) – test to determine the quality of bonding between the well casings and cement utilizing sonic measurement techniques.

⁷ Variable Density Log (VDL) – similar to a CBL but used ultrasonic measurement techniques to determine additional details with respect to annular cement bonding quality.

Reasoning and Benefits

These suggestions not only benefit landowners, the environment and state residents; they also provide benefits to the drilling companies. Drilling companies may argue about the cost of higher standards with regard to increased drill time and material expenditures, but the costs are often negligible considering the positive benefits achieved with proper cementing practices.

Executing and implementing best practices and standards throughout the drilling process is the only way to ensure the safety of rig personnel. Failed cement jobs are the primary cause of loss of well control (LWC) resulting in injury or death of rig personnel and substantial damage to rig equipment. In addition to minimizing LWC potential, there are many positive outcomes resulting from the implementation and practice of better cementing standards:

- Safety improved by reducing the risk of well blowouts
- Environmental protection by reducing risk of upward gas migration
- Reduced well control problems save drilling time and cost
- Well life is extended
- Reduced negative incidents increase public confidence and cooperation in the industry
- Reduced potential for loss of well production due to annular gas migration
- Reduction in potential OSHA and DEP fines by increased safety practices
- Lowered risk of environmental clean-up costs resulting from gas migration contamination(Isolating 51)

This brief list only touches the tip of the iceberg. The overall positive impact affects all involved parties from the drilling companies to the unsuspecting resident whose drinking water comes from a reservoir located next to a natural gas well.

The increased cost to state departments for adding and retaining adequate personnel to perform the tasks as set forth in this proposal will be offset in various ways. Initial costs would be offset by increasing new gas well permit fees. Another potential source of revenues to offset costs will come from substantial revenues collected in fines for DEP violations. Initial installment of new policies will generate

additional fines revenue as more violations are found during the program rollout... Long-term funds will continue to come from permit fees, but will be augmented by re-allocating funds currently used to combat and correct environmental and public damages resulting from poor drilling practices.

Closing Remarks

DEP predicts to issue approximately 5200 Marcellus well permits in 2010 (Wilber). Given the amount of documented methane migration cases in comparison with the total count of active Marcellus wells, the odds of fresh water contamination resulting from poor well construction is approximately 0.03 or 1 out of every 30 wells. This translates to approximately 173 potential disasters when those wells begin construction, a very scary and possible reality.

This proposal focuses on only one aspect of well construction, but one that is a major threat to Pennsylvania. As lawmakers begin to tackle the many issues concerning the extraction of natural gas from Pennsylvania's Marcellus shale, various other standards and processes will also need to be analyzed to improve the safety and protection of Pennsylvania's residents and environment. This proposal is intended as a jumping board for additional policy reform.

References

- American Petroleum Institute. Hydraulic Fracturing Operations-Well Construction and Integrity Guidelines. Washington: API Publishing Services, 2009. Web. 26 June 2010. [<http://www.api.org/Standards/>](http://www.api.org/Standards/).
- . Isolating Potential Flow Zones During Well Construction. Washington: API Publishing Services, 2010. Web. 26 June 2010. [<http://www.api.org/Standards/>](http://www.api.org/Standards/).
- “Pennsylvania DEP to Drilling Companies: Gas Migration Events Are Preventable with Proper Well Construction and Oversight”. PR Newswire 13 June 2010. Web. 26 June 2010. [<http://www.prnewswire.com>](http://www.prnewswire.com).
- Pennsylvania State. Title 25, Pennsylvania Code, Section 78.81. Harrisburg: State of Pennsylvania, 2010. Web. 26 June 2010. [<http://www.pacode.com>](http://www.pacode.com).
- . Title 25, Pennsylvania Code, Section 78.85. Harrisburg: State of Pennsylvania, 2010. Web. 26 June 2010. [<http://www.pacode.com>](http://www.pacode.com).
- United States. Dept. of Energy. State Oil and Natural Gas Regulations Designed to Protect Water Resources.
- Wilbur, Tom. “Pa. Seeks Stronger Drilling Rules to Combat Methane Migration”. Ithaca Journal 23 May 2010. Web. 26 June 2010. [<http://www.theithacajournal.com>](http://www.theithacajournal.com).